The American Biology Teacher

A service publication of
The National Association of Biology Teachers

teaching the life sciences from elementary grades through college

MAY, 1953 Vol. 15, No. 5

. . . Children's Fear of Animals
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THE AMERICAN BIOLOGY TEACHER

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The contents of previous issues of *The American Biology Teacher* can be found by consulting the *Education Index* in your library.

THE COVER PICTURE was taken by Nat Levine, a biology student at Mumford High School, Detroit, Michigan. It was taken with a $2\frac{1}{4} \times 3\frac{1}{4}$ Bush Pressman Camera, on Super Pan Kodak Press Type B film, with a 1/100 second exposure at F 16. Nat, a student photographer for the student newspaper, took the picture as a part of a biology project.

The American Biology Teacher

Vol. 15 MAY, 1953 No. 5

Animals and Why Children Fear Them

JOHN D. WOOLEVER, Mumford High School, Detroit, Michigan

"So this is where they study Nature and have all those horrible snakes and things. I keep telling Betsy how dangerous those terrible bugs and things are, but she insists on talking about how much she likes them. They seem to do all sorts of things with those ugly little beasts." This was overheard during an "Open House" held by a school celebrating Education Week. The main purpose was to show parents the progress and activities of the local school. As is usually the case, both teachers and parents learned a lot about each other.

Unfortunately a remark such as the one overheard is not unusual, but typical of many parents. Usually they are not familiar with many of the science programs being carried on in the schools and some parents do more harm in five minutes of such conversation than it takes a teacher to rectify in an entire semester. Much of this harm even though seemingly slight, interferes with a child's thinking and behavior enough to retard his maturation, in a world full of strange and interesting living things.

Children seem to have a natural attraction to living things. Due to their environment, millions are not in contact with plants and animals as much as they should be, even with our expanding camp programs and outdoor field trips. As a result they acquire many little fears and undesirable attitudes toward living things long before they have a chance to find out for themselves. These little fears and anxieties interfere with their education and rational behavior in the classroom and outside of it.

They are frequently acquired from parents and acquaintances who most likely learned them from other prejudiced or misleading predecessors. It is the job of the science teacher, naturally, to rectify the situation, but educating the parents is the most difficult part.

It is not unusual to find an elderly person who has gone through life shuddering at the thought or sight of snakes and bugs. The personality of such an individual suffers, not to mention the fears he instills in the youngsters with whom he comes in contact. Imagine the innumerable garter snakes, frogs, toads and ladybird beetles that have been destroyed because fathers and mothers believed their children might be harmed or frightened by having the animals around. The animals' destruction frequently followed a few minutes after the children were found playing with them or caring for them as pets, unbeknownst to the parents and with little or no fear on the part of the children.

During a period of four years, more than nine hundred children in three elementary schools and two high schools were studied by

the author in connection with the anxieties and fears they had relative to common animals they came in contact with during their school years. The children studied were selected on the basis of their variety of experiences, economic level and residence. As wide a range as possible on these bases was obtained so as to see just how extensive the fear of certain living things extended throughout the grades. Written unsigned questionnaires, interviews and observations with anecdotal records were used as the methods in this study. Children from kindergarten to the eleventh grade were studied, with many of the students followed through several grades to check on their progress in the elimination or expansion of their anxieties.

This study was concerned primarily with anxieties or reactions to no real or substanial dangers of common animals. We can expect certain fears even though there is no threat in the immediate future, this is especially true of fear of lions, tigers, and the like, which may be commonly seen in a zoo or circus. Regardless of where a child may live, what he does in his spare time or whether he has science in school, he comes in contact with certain animals. It is these animals with which the study was concerned.

The animals which were named most frequently by the children in all grades and the most common reasons why they were feared or caused distress were as follows:

SNAKES, slimy, wiggle, poisonous
LEECHES (usually called blood suckers), such blood, stick tight, slimy
SPIDERS, poisonous, ugly, hairy
BEES AND HORNETS, sting, buzz
BEETLES, bite, sting, poisonous
CENTIPEDES, poisonous
WORMS, wiggle, slimy
CATERPILLARS, wiggle, hairy
RATTLESNAKES, poisonous
CRABS, bite
BATS, poisonous, hairy, ugly, many unknown reasons
RATS, poisonous
ROACHES, bite, unknown why feared
LIZARDS and SALAMANDERS, poisonous, wiggle, slimy
FISH, wiggle, slimy, some poisonous, bite, sting
BLUE-JAYS, peck, noisy
MICE, poisonous, bite
TURTLES, bite, slimy, unknown reasons
GERMS, sickness, death
SNAILS, slimy, unknown reasons
DEER, big, bite, kick, jump
GRASSHOPPERS, jump, spit tobacco

It is interesting to note that the things which were mentioned most, were likely to appear during the summer time or could be found in a biology laboratory or science room. In more than seventy-five percent of the cases the children could not distinguish between the poisonous and non-poisonous snakes. More than half of those who feared leeches did not recognize one when they saw it. More than ninety percent of those who feared bees, wasps and hornets, could not tell one from the other. Although proper identification isn't the most important factor in eliminating fear, in almost all the animals listed, more than half the children didn't recognize some of the animals from those closely related or similar in appearance.

The reasons given for their concern were mostly exaggerated. Some were unfounded. Others were entirely without immediate danger but temporary unpleasantness could be expected in some rare cases or through indirect causes. In more than twenty percent of the cases the fear was learned from parents and grown-up acquaintances. Less than eight percent had personal experiences which gave them reason to fear the animals they mentioned. The others just "knew" or "heard" about the reasons they gave. Many listed books, comics, movies, radio stories and television programs.

The children who listed their parents or adult friends as their sources of education regarding the characteristics of the animals, were asked to investigate the reasons why they had been taught to avoid or fear the things they did. Less than a fifth of these adults were present when someone suffered as a result of contact with the animal or suffered in some way themselves.

Wherever danger was expected, it was not always immediate, but results expected were

death, illness, loss of blood or incapacitation. These personal disabilities were expected also from the animal's sliminess, movements, bites and stings. It wasn't always the little immediate discomforts that resulted in anxiety, but what could be expected later on.

Upon questioning, many in the higher income brackets considered rats, insects, centipedes and caterpillars as dirty. Those in the lowest incomes rarely associated rats, roaches or bedbugs with filth.

Those who had cited examples of dangerous experiences with snakes, lizards, salamanders, spiders, centipedes, crabs and bats often insisted that they had been chased by the animals. These harrowing experiences appeared in the lives of high school students as well as elementary students. Verification was not requested.

Girls in most cases stated that the very sight of the animal, or its color made them uncomfortable. When experiences were traced in those who could remember first contacts with the animals, it was found that unexpected sight, movement or touching was most vivid in their memory. Often their dislike started there.

The amount of fear or intensity can not always be measured in the amount of noise or shrieks a child makes. This is especially true of girls in the upper grades. Boys were usually more accurate in describing their feelings when comparing their recorded admissions with their observed actions. Many boys expressed their fears by bravado and attempts to destroy the animal, large or small.

The animals feared in the lower grades by younger children differed little from those in the upper grades. As the boys grew older, they appeared to lose many of their anxieties of the smaller animals. This was not true of the girls, however. More than half of the girls acquired new ones as they grew older. Since children spend more time with their mothers, it would not be surprising that it was from them that children learned many of the irrational fears we are trying to correct.

The significance of the anxieties of this type is of relative importance. The science teacher is concerned in at least three ways. The first is as an educator attempting to eliminate fear and develop a clear thinking citizen and conservationist of the future.

The second concerns the interference with the accomplishment of the objectives of science education in general. The third although perhaps not as important, is the disturbance and confusion created in a teaching situation when a new specimen is brought in by an enthusiastic student for class study or when a specimen escapes his artificial home in the corner of the science room. It is difficult for a child to think clearly or act rationally towards wild life when he becomes ill looking at it or his heart skips a beat when confronted with the animal unexpectedly.

To alleviate these various undesirable situations, there are certain steps the science teachers can take. Proper activities and planned lessons will do much to erase or substitute anxiety for intelligent thinking and proper attitudes towards animals that once were feared. It is important to do this as early as possible in the science program.

FREE AND INEXPENSIVE TEACHING MATERIALS FOR SCIENCE EDUCATION

Free and Inexpensive Teaching Materials for Science Education, compiled by Muriel Beuschlein and James M. Sanders, similar to the Beuschlein list of conservation materials published in the February ABT, has been printed as a special supplement of the *Chicago Schools Journal*. Copies may be obtained, as long as the supply lasts, at ten cents each, or only the actual cost of postage for 25 or more copies. Write Louise Jacobs, Managing Editor, Chicago Schools Journal, 6800 Stewart Avenue, Chicago 21, Illinois.

INCREASE IN DUES

A letter from Secretary-Treasurer John P. Harrold indicates that an increase in dues, authorized at the St. Louis Meeting, should be announced at this time, with further details to follow in the October and November issues. The dues have been set at $3.75 domestic and $4.50 foreign.

On the Zernike Phase-Contrast Method of Microscopy

ARTHUR T. BRICE, Phase Films, Ross, California

Every microscopist knows that transparent objects show light or dark contours under the microscope in different ways varying with the change of focus, and depending on the kind of illumination used. Curiously enough, however, the wave theory of light was never explicitly applied to the problem of making visible the details in such objects, which differ only in thickness or refractive index, until many years after the German Ernst Abbe and the Englishman John William Strutt, Lord Rayleigh, between 1890 and 1896 had fully developed its application to the formation of images of objects the details of which give rise to sensations of brightness or color contrast in the human eye. Every microscopist is familiar with the general character of the images of transparent objects produced as a result of their theorizing.

In spite of a number of attempts to improve on it, the wave theory remains today the most useful explanation of the phenomenon and behavior of light in general. It leads to the conclusion that the microscopic image of illuminated objects is the result of a two-fold diffraction of the incident light (a) on passing through the object, and (b) by the aperture of the objective lens. This means that every point of the object, as well as every point in the aperture of the lens, contributes to the light vibration in any selected point of the image. In calculation we accordingly find a two-fold integration extending over the plane of the object, as well as over the aperture of the objective lens.

It is not my purpose to develop the calculation. In fact it is quite beyond my mathematical ability to do so. A lifetime interest in clinical microscopy, however, combined some years ago in the fortunes of war to result in investigations and contacts which have given me, I believe, a possibly unique knowledge of the background of human genius, personality, and effort from which the phase-contrast development in physical optics has arisen. Bear with me then, if you please, as we consider a few of the high points in the abstract thinking of the physical and mathematical masters.

It has been said that many of them put everything into an equation and never bring anything practical out of it. These are the ones who confuse us biological scientists the most. Neither Lord Rayleigh or Ernst Abbe could be justly classified in such a category. The practical result of their theorizing has served us well and faithfully for many years. Rayleigh believed that the calculation could have a practical bearing only if the diffraction process (or integration) over the surface of the objective lens, (b) above, were considered first, and then the pattern, (a) above, from different object points, were taken into consideration. Abbe, on the other hand, considered the diffraction, (a), by the object and the resulting images of the light source in the back focal plane of the lens as constituting the "primary" phenomenon. The diffraction, (b), by the aperture of the objective would then result in cones of light emerging from these primary diffraction images overlapping in the image plane and forming the final image by their interference. Neither of them carried out their calculations for a transparent object, and for 35 years the optical physicists and mathematicians of their day separated into opposing camps following one or the other of these two dominant personalities. It almost seems as though they were more concerned over which came first, the chicken or the egg, and to have forgotten that one must have an object usually of unknown optical characteristics before one can begin to produce an image of it by whatever optical means. Or else they may have become so entranced over the mysteries of optical gratings that they considered the probability of any other type of object ever being worthy of microscopic examination as equal to zero for all of their own practical purposes.

This remained an approximately accurate description of the situation as nearly as I can determine for about 35 years until in 1932, at the University of Groningen, Netherlands, a professor of physics, Frits Zernike, realized that these two controversial beliefs were only different pictures of the same general diffraction phenomenon and that both methods of calculation must therefore always lead to the same final result. He carried out both calculation procedures for a completely transparent object and the final result of both, as he had predicted, was the same. It indicated a constant difference in the behavior of the light at the rear focal plane when the object was transparent as compared to when the object was opaque. In his own words "Starting in 1932 from the two points at which the German Abbe in 1890 and the Englishman Rayleigh in 1896 had stopped, I found by calculation, which I was able to confirm by experiment, a constant phase difference between the direct and the refracted beams at the focal plane, when a completely transparent object is illuminated by transmitted light under a microscope lens. A number of different means of changing the phase of light are available. The physical problem of making visible the smallest phase differences produced by a transparent object accordingly resolved itself into the problem of separating the direct and the indirect or refracted beams sufficiently so that the phase of one could be altered without changing that of the other. This was solved quite simply by developing a suitable shape for the light source." In other words, Frits Zernike came out of his equations with a good solid bone in his teeth.

There was at once some uncertainty as to how nourishing to microscopical science this bone might be. The constant difference remained effective in producing images of transparent details for only as long as the phase difference produced by the object was of an order of magnitude of less than about 1/20 of the wavelength of light, or in other words, for only as long as the sine of the angle expressing the difference in refractive index at the object was small enough so that it might be considered as zero for all practical purposes. But still it was an interesting bit of physical-optical pabulum. A small matter. But sometimes there is no telling how far-reaching the consequences of a small matter may be, and Frits Zernike talked about it to his best friend on the Groningen faculty, the Professor of Botany. "Do you suppose," said the latter, "that I could see the chromosomes in an unstained onion root tip with it?" It may be well for every microscopist making a start with phase-contrast to remember Dr. Zernike's answer. For until all microscopic objects of interest have been examined, or their complete optical characteristics become known so that we can tell what structures fall into the sine of the angle equal to zero for all practical purposes category, no other answer can be given to a similar question. He said: "I don't know. Bring them in and we shall see."

The Professor of Botany brought in his unstained onion chromosomes and saw. Having seen, he told the Professor of Physics quite emphatically that he must take this discovery to the Carl Zeiss Factory, where the best optical instruments of that time were made. The technical development of design and instrument manufacturing procedures accordingly was begun.

The idea that an exact image of invisible optical differences in transparent objects can be produced by any means whatever other than staining has been naturally a very revolutionary one, even in the minds of people who may observe something under a microscope almost daily in carrying out certain prescribed laboratory procedures or tests. To understand it one must go back to the very beginnings of optical science. The apparent bending of an oar at the point where it met the water had been noted and discussed as an optical effect by the ancient Greeks before the time of Christ, but the quantitative laws governing this phenomenon, known as refraction, were not formulated until the 17th century, when theories showing some resemblance to the modern wave theory began to appear. About a hundred years later, in 1850, J. B. L. Foucault proved experimentally that refraction meant simply that while light travels in a vacuum at a speed of approximately 186,000

miles per second, it does not travel at exactly that same speed in passing through transparent media such as air, water, glass, and other transparent gasses, liquids, or solids. Depending entirely on the thickness of such a transparent object, or in other words on the length of the path of the light through it, the actual retardation by a transparent object no more than a few microns thick, such as a microscope slide preparation, is indeed infinitesimal, almost beyond concept of the imagination. It is these infinitestimal differences which Zernike has taught us to harness in such a manner that the light produces a visible image of the smallest differences in the nature of the transparent substances through which it passes.

This is indeed a very far-reaching thing. The amount of retardation imposed on the light by such substances is a specific characteristic of the substance itself. If precisely known it may lead to the exact identification of the substance by chemical formula and name. The Zernike Phase-Contrast microscope does not go that far in precise identification. It is, however, the first step in that direction, which in the words of Bennett, Jupnik, Osterberg & Richards, in their book on Phase Microscopy, published by John Wiley & Sons, Inc., in 1951, marks "the beginning of new and outstanding progress in the field of microscopy." Already a second step has been taken. In April, 1952, at the meeting and exhibition of the Physical Society in London, a pioneer model of an instrument, by means of which, if its thickness is known, the refractive index of an object can be measured accurately by direct microscopic examination, was demonstrated. It will probably be known as the Interference Microscope. It is not yet commercially available.

The purpose of the Phase-Contrast Method is the production of images of details in transparent parts of an object differing from one another only in thickness or refractive index. The image itself is characterized by one outstanding feature which enables the microscopist to judge, by immediate inspection, whether or not his light source and optical elements are properly aligned, centered and focused, regardless of his knowledge of the theoretical considerations on which the design of his instrument has been based. The system in its broadest sense produces a re-distribution of the total light energy. Where a transparent detail of the object appears dark in the phase-contrast image, the light energy transmitted by such detail has not been absorbed or reduced, it has simply been re-distributed throughout the whole image. Consequently, transparent details of relatively large dimension, which present a longer optical path to the light than their environment and appear dark in the image, are surrounded by a bright halo. This is well shown in the Illustration No. 1. It is the photograph, by Zernike's method, of a sperm cell of a grasshopper. It was given me in 1945 by Dr. Kurt Michel, then Chief of the Microscope Division of the Carl Zeiss Company, who was probably the first biologist to have an opportunity to work with the Zernike method. He also gave me the photograph, Illustration No. 2, made by means of the conventional brightfield microscope. The halo around the edges of the cell in the phase-contrast image is unmistakable. The chromosomes, though much smaller, also show the halo effect. It is not impressive about the smallest and finest structures such as the mitochondria. In the conventional brightfield photograph image of the same cell, Illustration No. 2, it can just be seen that chromosomes and mitochondria are present, although they could only be positively identi-

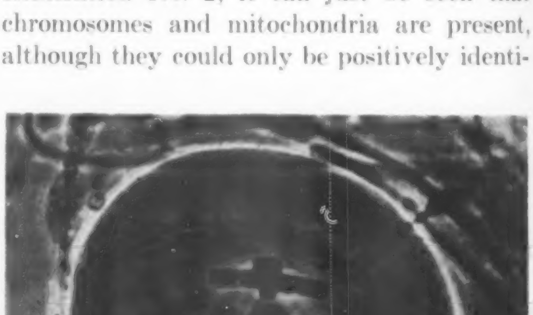


ILLUSTRATION NO. 1

Phase-contrast image of a grasshopper sperm cell.

fied as such by an experienced microscopist, fully familiar with the characteristics of these structures. Such a microscopist might conclude from such a comparison that the optical path differences imposed on light by the transparent mitochondria and chromosomes were of an order of magnitude which he might readily calculate.

The setting up and manipulation of the Phase-Contrast Microscope requires very little additional knowledge or experience on the part of the individual using it. The re-distribution of light energy, which has been referred to, is accomplished by a narrow light-absorbent ring situated at the rear focal plane of the objective lens. This ring must be so centered that all of the light from a corresponding ring in the condenser lens system passes through it. This adjustment requires inspection by means of an auxiliary special magnifying eyepiece which permits the observer to see the two rings. This is the only additional adjustment required. After it has been made, its correctness can be checked quite simply, as I have already mentioned, by looking for the halo effect in the image of any object with which the operator is familiar.

The most important contribution that the Zernike method has made to the teacher of biology is undoubtedly the ability to demonstrate to students the dynamics of the microscopic life processes. Transparent microscopic organisms do not have to be killed and stained in order to be made visible. By means of films, dynamic processes, which have heretofore been seen by only the most advanced students, can be shown to every class.

It is not the purpose of this paper to describe the technical features of the production of such films. In general it may be said that it is only necessary to mount a motion picture camera in the place of the eye or the still camera above the microscope. The real problem in making such films lies, not in the optics, mechanics, or photography of the filming process itself, but in the preparation of the living organism for that process. Dr. Michel, who produced the photography of the first Phase Film on "Meiosis—in Spermatogenesis of the Grasshopper" worked for almost

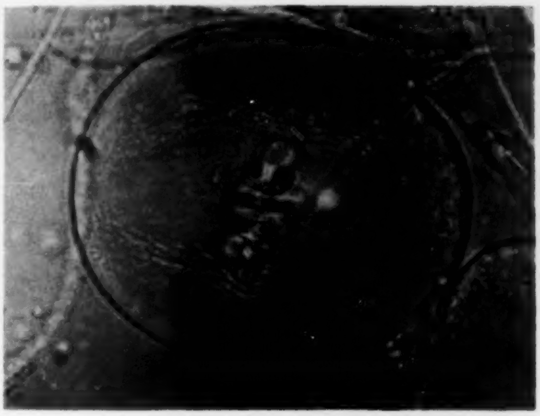


ILLUSTRATION NO. 2

Conventional bright-field image of the same grasshopper sperm cell shown in illustration No. 1.

three years before he was able to discover a cultural procedure and medium in which these cells would live and multiply normally on the stage of the microscope as in the insect's body. Of course, as is now well known, many such cultural procedures have been developed and proved, for many sorts of microscopic creatures, including procedures for the growth on artificial media of human cells and tissues. A vast field awaits photography as the servant of the biological sciences.

I shall conclude this account by quotation of a few comments that have been received from teachers and students after seeing the first phase film made by Dr. Michel.

By the Chief of a State Bureau of Audio-Visual Education:

"This film, showing the basic process underlying all growth, has many applications in instructional programs. Certainly its use should not be confined to the biological sciences. Materials of this type have a definite place in science teaching even in the lower grades."

By a Professor of Zoology:

"The film on meiosis is a highly-useful, graphic display of a complicated process."

By a Department of Zoology Chairman:

"The film on spermatogenesis is certainly a thing which every department of biology should have available to show to students."

By the President of a Junior College:

"An experimental showing of your film to a class that had not yet studied the topic gave them a

fairly clear idea of the general principle involved."

By a Teacher of Biology:

"After previewing your phase film on meiosis I feel that I shall never teach the subject without using this film."

By 10th grade second term biology students:

"For the first time I was able to see right before my eyes the process of mitosis. More important still, I was able to understand it, something that I couldn't do after half an hour with my nose in the textbook."

"The film helped clear up some of my doubts about mitosis."

By 10th grade, first term biology students:

"Before viewing this film I had not known how cells multiplied without ripping."

"After seeing the film I learned that chromosomes were contained in the nucleus of the cell."

"Before seeing this picture I knew little about cells. I now know that there are cells in our bodies which by division make us grow. I know there are many people like me who are in the dark about biology. I think this picture will definitely help these people."

Card Holder for the Opaque Projector

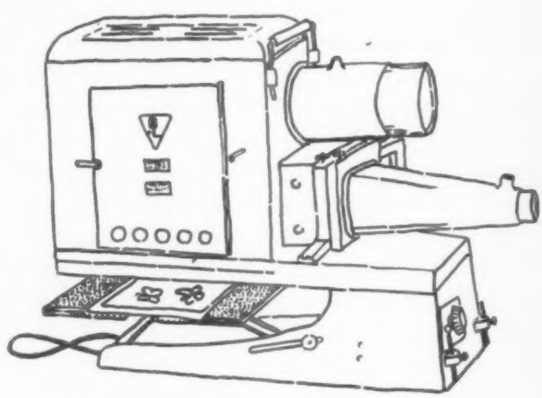
O. W. NEHER, Manchester College, North Manchester, Indiana

The purpose of this device is to center and align projection materials without the embarrassment of trying to get them in the proper position while talking to the class. Many opaque projectors are idle because of this difficulty. With this "helper" one mount can be shown while the other is inserted under it. Then the first can be removed, almost instantly, and the second is ready for use. In this way a number of pictures can satisfactorily be shown in a few minutes.

Our projector, a Bausch and Lomb, projects materials up to about six inches square. We make our mounts by cementing (rubber) maps, drawings, charts, pictures, written or printed materials to the central part of an $8\frac{1}{2}$ by 11 inch card, which fits loosely in the card holder. A cardboard frame, $8\frac{1}{2}$ by 11 inches on the outside and $6\frac{1}{4}$ by $6\frac{1}{4}$ inches on the inside, is used when centering the materials on the mounting cards.

Subjects for projection can be gotten from almost any place. Ours come from calendars, magazines, student drawings, catalogs, books, newspapers, teachers, nature material as dried starfish, insect mounts, and the like. Really good picture books like Zim and Gabrielson's "112 Birds" in full color may be bought in pairs, taken apart and all the pictures mounted.

This device has brought our opaque projector out of the moth balls and made it the most used of all the projectors in the biology department.



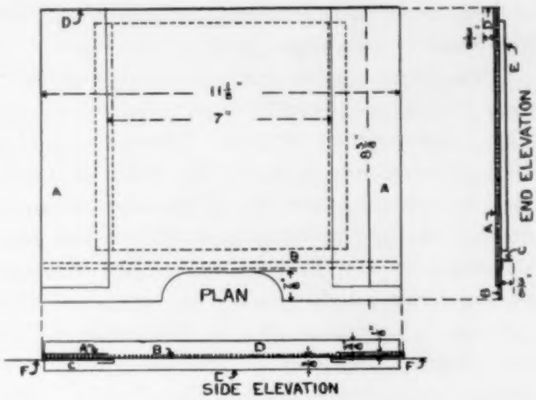
Projector with card holder pulled about half way out.

This card holder is essentially a strip of sheet metal $9\frac{1}{2}$ by $15\frac{3}{4}$ inches in size folded up and in at the ends and up at the back. Two other pieces are soldered to this to hold it in position in the projector. For other makes or models of projectors these last two would need to be differently shaped and located. The large folded piece is shaped so it encloses an opening $\frac{1}{8}$ inch high and $11\frac{1}{8}$ inches long into which the mounts are inserted for projection.

In the sketch of the projector the mount holder is pulled part way out to show its location and the location of the card. The holder is dotted.

In the plan the parts marked "A" are the "folded in" parts of the long strip and these hold the ends of the mount down. "B" is the

bottom of this strip and on this the mount rests while it is being shown. "C" is a strip that is soldered on below to keep the holder from being pushed in too far. "D" is the part that is turned up at the back to stop the cards at the right place and it also protects the eyes of people sitting near the projector. "E" is bent to make the grooves that engage the inner edges of the regular opening in the bottom of the projector. At "F" are shown the metal edges of the projector, referred to in "E." The curved cutout in the front of "B" makes it easier to grasp the mounts for their removal. The dotted lines represent edges of the mounting card in the Card Holder.



Opaque projector copy holder for 8½" × 11½" cards.

All the metal work for this card holder was done with a hammer, tin snips, machinist's vise, soldering iron, and a wide piece of strap iron ⅛ inch thick. Finally the assembled apparatus was thoroughly washed with soap, rinsed, dried and given a coat of black crinkle finish.

The Superior Science Student in the Senior High School*

PAUL KLINGE, Biology Teacher, Thomas Carr Howe High School, Indianapolis, Indiana

It is altogether fitting and proper for science teachers to give attention to what Dr. Morris Meister has called "the deviate learner." Although many learners fit into the accepted pattern, the deviates constitute a large enough number for our concern. Since they do not learn in the usual manner, they constitute a challenge not only to the educator but to the scientist. The obligation of scientists is to study deviations from the norm and, not only to describe these variations, but to explain the why of these deviations and find out how they may be utilized. Since the deviate learner perceives the field of science from a different viewpoint and in a different manner, the usual methodology for the average learner may not be applicable. We are met with the problem of what to do and how to do it, regardless of how radical the solutions may be in comparison to the orthodox learning problem. In the Stalinist vocabulary, deviationism is a very ugly word. When scientists are given that label in Russia, they loudly embrace the current orthodoxy or they silently disappear. The deviate learner *can* be compressed into the mold of the majority; it is indeed the usual program in many schools. But the potentialities of the deviate learner may not be revealed when an orthodox solution is used. As science teachers we must not be afraid of tackling this problem of the deviate learner with an eye to the development of his potentialities, regardless of the somewhat radical solutions to which it may lead.

It is my intention to discuss the possible role of the science teacher on the senior high school level in encouraging the superior student, the deviate learner, whose rate of learning is above average.

At Thomas Carr Howe High School in Indianapolis, Indiana, a school of about 1300 pupils and the smallest and the newest of the seven public high schools of the city, an effort was initiated five years ago to meet the problem of the superior student in the sciences. Our solution for the problem was not radical;

* The revised text of a paper presented before a Joint Session of The Science Teaching Societies, affiliated with the AAAS, in St. Louis, December 27, 1952.

at least it was a beginning, and one which has had some tangible results.

The science curriculum consists of a 10th year biology course, 11th year chemistry and 12th year physics courses. There is no 9th year science, and any of the three sciences may be taken to meet the graduation requirements. After the first 12 weeks of the fall semester, in the sophomore biology classes, each teacher is asked to list the students who fall into one or more of four categories. The first group consists of the students who have definitely decided to major in science. The second group takes in the ones who have indicated an intention to minor in science. The third group consists of all who are making the top grades in the class. The final group includes the students who show some especial aptitudes in science that may have been shown by hobbies or special interests.

From this list there are chosen enough for one class for the spring semester of biology, labeled the "Special Biology Class." Each student is asked for his consent to be included in the class. This procedure, and the conflicts in program making, cut the group to an average class size.

The curriculum of the special class includes the same sequence of topics as is found in all of the other biology classes. However, much of the drill work and paper work unnecessary for the really gifted student is eliminated so that there is a surplus of time for each unit. With this time the student is asked to pursue a semester project, which is a real scientific investigation rather than an intensive library research exercise. This time is also used to present every science teacher in the school in a lecture on a topic which ties his subject to the unit being studied by the class. Special speakers from outside are also used, and the caliber of these has been uniformly and surprisingly high. None have refused an invitation to speak. The grading requirements for the special class are the same as for all the other biology classes. This is done to silence the complaint that the special class is too hard and too exacting in its requirements. Many of the superior students would not like to risk the loss of a good grade in a special class when that grade may come rather easily in a regular class. Especially is this true when the colleges base so much on the academic record.

Other features of this program include the checking of all science majors as to their progress throughout the remaining years. Each one is encouraged to find one science teacher who will act as his advisor, not only in academic and vocational information, but as a sponsor for a project which we think he should be pursuing in his high school career in science. The head of the science department, Mr. Virgil Heniser, directs this program. His role in encouragement, running interference, and his demand for a high quality of instruction, regardles of method employed, has been vital to the success of the program. We cannot force any student to take any of our recommendations, so that our job has been one of salesmanship—selling the vocations in science, selling the desirability of certain train training for such vocations, and selling the advisability of pursuing a high school course that may lead to scholastic aid in college.

One of the first lessons in dealing with the superior student it would seem, then, is the inadvisability and even the impossibility of forcing these students into any course of action which is not required for the average student. This is the 11th point of Dr. Curtis's list of basic science teaching principles, in which he insists that effective learning is possible only when the learner sees that the program he is in is a privilege and an obligation. Far too many ambitious programs for segregating the superior students or even the retarded students, and giving special instruction with special requirements have crashed on the rocks of student unwillingness, parental resistance to special labels for their children, and the rather strong inertia among teachers to anything that is different from the average. The selling of any program for the deviate learner to the remainder of the faculty, to the sudents, and to the parents, is mandatory. When the program gains prestige, and when the student and teacher personnel involved

are convinced that it is valuable, it will progress under its own momentum.

The second lesson that we have learned is that the superior student is interested in and needs a continuous evaluation of his role in science. The grading system must be such that he may see precisely how he is being evaluated, so that he too may enter into the process. The point system is excellent for this purpose, because the "A" student soon sees the differences among the "A" students, and each finds himself competing for the highest group of "A's." Too, there needs to be a continual explanation of how evaluation may be made from an analysis of the unit tests. In this way the superior student, who is interested in the subject anyway, will evaluate himself and ask for other evaluations of his weak and strong points. To the superior student, the Socratian admonition of "Know thyself" is important and necessary. This evaluation needs to take into account an explanation of how learning takes place, so that self-examination can be used to improve his learning process, which may be a deviate one. For example, we use the description of the learning process as given in the M. I. T. Bulletin on this subject.* The superior student is interested in how he learns, and we feel that this is worth one day, at least, in the semester.

The third point is that the superior student must be taught a critical attitude. The scientific method implies a scientific attitude. Too often the superior student, whose powers of memory are usually great, accepts too much at face value. To develop these critical faculties; to carefully examine all conclusions, whether his own or from others, is a sine qua non for the budding scientist. When he begins to become critical, he begins to have questions. When he has questions, problems appear for his consideration. When he attempts to solve these problems in a critical manner, he has achieved scientific success. We give extra points for errors a student finds in a teacher's lecture. This may lead to a battle of authorities, and we recognize full well this danger. When students find contradictions within and among textbooks, and with the teacher, he is often intrigued and spurred to find a true explanation either in his own experience, or in his experiments. When this critical spirit is encouraged, with tangible grades, it is surprising to see the increase in and variety of reading as well as the experiments performed.

Fourth, we have discovered how much the superior student is interested in the theoretical aspects of science. This preoccupation with the theoretical outlook on science is easily seen in the great interest shown in science fiction, with its imaginative treatments and its insistence on the theoretical being made possible. Presenting the current theories in the topics of the course becomes stimulating to the imagination of the superior student. College textbooks and current science literature are good sources of this, not only for the teacher but for the superior student. A class discussion on science research, with some emphasis on the hypotheses proposed, offers good exercise in a careful analysis of theories. Technical and hard to compile as they are, the theories of cancer cause are excellent to discuss in the unit on the cell. The multitude of theories used in modern genetics, too, are good exercises in imaginative flights for the mind of the superior student. Alertness by the teacher in gathering current theories on all biological topics will be valuable when dealing with the superior student.

The final point concerns the method of identification of the superior student in science. It is quite obvious that the student with an IQ of over 135 offers wonderful potentialities. But these are not common. Are there students who may be classified as superior science students with IQ's below that? Our answer is a vigorous affirmative. The students with IQ's between 110 and 120 may show greater interest and ability than those in the 120 to 135 group. Teacher recommendation we have found to be a highly satisfactory method of identifying these superior students. If there is a test we would like to use it, but we have not found it. The verbal emphasis in the IQ test may not identify the superior stu-

*"You and Your Students." Massachusetts Institute of Technology, 1950. Distributed by National Science Teachers Association.

dent adequately. After all, identification is possible when the student is helped with an enriched curriculum, and he *responds* to this help. The student is identified to himself and to the teacher when the response is such that he goes several steps further than necessary. This is a pragmatic approach. The real potential scientist must be independent in his work and show real interest in it. No matter what the IQ, if the student does not respond to the extra help we cannot consider him a potential scientist. Identification is a matter of response to enrichment, and the teacher is the best judge of that.

In Dr. Curtis's keynote speech, the basic principles of science teaching he enunciated concern the deviate learner because many of the principles apply to the learning of the *individual student*. When we are ready to approach the student with an idea of discovering how *he* may best develop *his* potentialities in the field of science, with its body of generalizations and its method and attitude, then we are indeed ready to teach the deviate learner. But if we insist on a careful molding of these students to the orthodox pattern of learning, either at the insistence of the colleges or the community, then we will not be prepared mentally to deal with the deviate learner.

NEW EDITOR-IN-CHIEF

B. Bernarr Vance, Assistant Editor for the past two years, a co-founder of NABT, and a member of the Editorial Board of ABT since it's beginning, has been appointed by The Board of Directors as Editor-in-Chief to fill the vacancy created by the resignation of Editor Breukelman, effective following the May issue. Mr. Vance was formely Instructor of Botany and Bacteriology at Miami University, entering secondary school science teaching and supervision to do some writing in that area. He is co-author of such widely-used secondary school science books as "Biology for You," by Vance and Miller, "Biology Activities," by Vance, Barker, and Miller, and "Science for Everyday Use," by Smith and Vance, all published by The J. B. Lippincott Company. He has also authored "Cancer, the 'Teenager's Problem Too," and several college laboratory manuals still in trial use. Mr. Vance contributes regularly to science journals, does occasional editorial work for industries and publishers, and speaks frequently before national and regional conventions. At present he is Chairman of Sciences at Daniel Kiser High School, Dayton, Ohio, Assistant Professor of Sciences and Education, The University of Dayton, and part-time Instructor of Biology, Wittenberg College. Besides teaching life science, professional education, and psychology courses, he directs the in-service training of science teachers for the university. Mr. Vance has traveled extensively in the Western Hemisphere, photographing color slides as a hobby for lecture appearances. Mr. Vance says, "With the continued cooperation of other Staff members, and the whole-hearted support of NABT's increasingly large membership, we are aggressively planning to place ABT at the top of all science teaching service journals, and make it more than ever a 'must' for

all teachers of the life sciences from the elementary grades through the college level." Announcement of possibly two Assistant Editors, and an Assistant Managing Editor, will be made in an early fall issue together with other changes in the Editorial Staff.

EDITOR'S NOTE: The September, 1953, issue of *The American Biology Teacher* will, for the first time since February, 1942, carry the name of a new editor-in-chief, as announced in the foregoing article.

Probably the same issue of *The American Biology Teacher* that carries the announcement of a new editor should also carry the swan song of the old one. However, at the time of preparing the May issue I am just emerging from a three-month cocoon made up of hospital beds, penicillin needles, cortisone pills, calcium syringes, and the like. My wings are still flabby and I am in no mood to do the reminiscing to which I think my eleven years of service entitles me. I shall visit with you in the October issue.

JOHN BREUKELMAN

LETTERS

Dear Mr. Breukelman:

The article by Raymon Greb concerning laboratory drawings suggests a point worthy of some consideration. One objection which Mr. Greb cites to the use of laboratory drawings is that "Many students are unable to draw." I take it that this is not necessarily his opinion, but was used by some of those opposed to the practice.

On the basis of personal experience I am inclined to believe that this is an excuse rather than a legitimate objection. It is made often, by students and sometimes teachers.

Yet in twenty-five years of teaching, averaging at least (and this is a conservative estimate) forty students a year to whom I taught zoological and botanical drawing, I have encountered *just one* person who seemed incapable of learning to draw.

This is not to imply that many of these would ever become accomplished artists. Oddly enough, in all my experience I encountered only one person who was well on the way to becoming an accomplished biological artist.

The chief difficulty is the time involved. When I "took" drawing in high school, my art teacher was nearly driven to distraction by my "fuzzy" lines. Yet about 1940 some of my drawings of insects were exhibited at the American Museum of Natural History. Many hours over many years was required to develop this ability.

Nor is my case unique. Dr. Whedon told me of a student he had—a girl—whose drawings were simply terrible. Yet later she obtained a museum position in which she had to make drawings of echinoderms, and turned out beautiful work.

It is my opinion, based upon many years of experience and observation, that all students of science, but especially those of the biological sciences, would profit greatly from some art courses. The artist, like the naturalist, has to *look* at things, for nothing in nature actually appears as our eyes tell us it is with a single glance.

Of course the reverse is true: artists profit from a study of biology, especially anatomy. It was surely no mere circumstance that Leonardo da Vinci was an anatomist as well as an artist.

Sincerely yours,

CYRIL E. ABBOTT,
419 S. Poplar St.,
Centralia, Ill.

Dear Mr. Breukelman:

I thought you might like to know that we have enjoyed receiving your journal, *The American Biology Teacher,* during the past year and that its contents have been very useful during discussions that have arisen in committees and for several projects that we have undertaken. It has proven valuable in the preparation of the *Bio-Sciences Newsletter,* which is now felt to be one of the most important contributions that the AIBS can make to international scientific cooperation.

We hope you will be able to continue mailing your journal on an exchange basis with the AIBS BULLETIN. If the Institute can be of service to you in any way during the next year, please feel free to write to us at any time.

Sincerely yours,

ILEEN E. STEWART,
Managing Editor,
AIBS Bulletin

Dear Mr. Breukelman:

Sometime ago your publication, *The American Biology Teacher,* has been added to the List of Periodicals indexed in the *Education Index.* It occurs to us that so far you have not mentioned this fact either on the cover of your magazine, or on the contents page. To make a suggestion to this effect is the purpose of this letter.

It happens very often that library patrons, research workers and students, especially when working without the help of the librarian, search only

through the current issues of a magazine, as far as they are on the shelf. They do not realize that the periodical is regularly indexed and that earlier material is just as easily available through the Index as current articles. For lack of this information they often turn to other publications, while a line on the title page or in connection with the table of contents, would inform them how easy it is to explore back numbers.

Maybe you also would consider running a note similar to the ones suggested on the enclosed sheet.

May we hear from you soon?

Cordially yours,

THE H. W. WILSON COMPANY
J. E. KRAMM,
Editorial Correspondence

EDITOR'S NOTE: The statement concerning the indexing of *The American Biology Teacher* articles may be found in this issue, and in succeeding issues, at the end of the Table of Contents.

EDITOR'S NOTE: In his letter submitting "On the Zernike Phase-Contrast Method of Microscopy" for consideration as an *American Biology Teacher* article (see page 124), Mr. Brice included the following note of interest to biologists.

Since preparing this paper, I have been advised within the last few days that Professor Frits Zernike has been, during the past two months, awarded the Rumford Medal of the Royal Society of London, and the honorary degree of Doctor of Medicine by the University of Amsterdam, Netherlands, for his achievements referred to in this paper. The latter award is surely a most unusual distinction, which has been very seldom made throughout modern history, and I would like to suggest that if you accept my paper for publication, an Editor's note, or footnote, announcing these awards would be very appropriate. The Rumford award was made in London on December 1, 1952, and the honorary doctorate in medicine on January 8, 1953.

Trusting that you will find my paper sufficiently interesting to present to your readers,

Sincerely yours,

ARTHUR T. BRICE

Dear Mrs. Beuschlein:

. . . Offhand I would not have any suggestions to improve still further your Journal. It is an excellent publication and gives biology teachers not only inspiration but excellent ideas that can be incorporated in the teaching program with great benefits to all concerned . . . .

Cordially yours,

DENOYER-GEPPERT COMPANY
By F. M. KITTNER

Biology in the News

Bats by Andreas Feininger, *Life*, March 2, 1953, pp. 88–93.

A group of excellent pictures and short paragraphs which may change your opinion of bats and their activities. Wonderful bulletin board material.

The Beauty Clinic by Ruth Murrin, *Good Housekeeping*, March 1953, pp. 108–112.

Learn how to exercise while doing the house work. This is a graphic presentation of the ways by which you may do this most effectively.

My Customers Get Gardening Fever Every Spring by Milo G. Coplen, *Sat. Ev. Post*, March 21, 1953, pp. 32–33 & 78–79.

The peculiar antics of some people when they start beautifying their yard and garden. A course in basic biology would have helped all of them.

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Pills Are Getting Smarter by J. D. Ratcliff, *Colliers*, March 14, 1953, pp. 70–73.

Ever wonder how pills are made? The problems of the pill makers and the methods they use to effectively produce the present day wonders makes interesting reading.

Brown-eyed Parents, Blue-eyed Child. Why? by Dr. James V. Neel with Murray Teigh Bloom, *Colliers*, March 7, 1953, pp. 11–14.

Answers to 35 commonly asked questions about our inherited traits. For your more intelligent students.

In the Woods, I'll Take the Tenderfeet! by Ralph Bice, *American Mag.*, March 1953, pp. 28–29 & 94–98.

A veteran Ontario guide describes how people act in the woods. He makes you feel the relaxing effect of being in close touch with Nature.

Are Patent Medicines Dangerous? by Robert L. Heilbroner, *Cosmopolitan*, March 1953, pp. 32–37.

Valuable information about "remedies" quack and otherwise and about the work of government agencies striving to protect the credulous public. Interestingly told.

Do We *Need* Milk-Dating? by Murray Teigh Bloom, *Redbook*, March 1953, pp. 34–35 & 96–99 & 104.

What does the date on the milk bottle really indicate? This author discusses some popular misconceptions about milk handling practices.

Fish Are Not *Only* for Frying by Lionel White, *Redbook*, March 1953, pp. 48–49 & 61–66.

Fishing for fun is the great American therapy for living in a rush. All the family can enjoy it. Fishing gear, regions for good fishing and descriptions and pictures of many kinds of fish are all treated in a most interesting manner.

"Mankind's Most Terrible Plague," *True*, August 1952, pp. 57–58.

This is a striking story of the syphilis disaster before the days of antibiotics and 606. (Thanks S. P.)

Biggest Free Show in New York by Milton MacKaye, *Sat, Ev. Post*, Feb. 28, 1953, pp. 22–23 & 59–67; March 7, 1953, pp. 32–33 & 101–107.

The American Museum of Natural History is New York's great show window of Nature. This is a general description of the collections made by their explorers and of the exhibits prepared by their great staff of specialists.

The X-Ray Cannon and the Rotating Chair by J. D. Ratcliff, *Colliers*, Jan. 3, 1953, pp. 36–38.

X-ray therapy has been most effective for superficially located cancers. This article describes a method of getting massive doses of X-ray to deeply-placed cancerous tissues without damaging the skin and other over-lying tissues.

Between the Devilfish and the Deep Blue Sea by Richard G. Hubler, *Colliers*, Jan. 24, 1953, pp. 40–43.

Skin-diving provides sport for rugged individuals as well as an opportunity to study the wondrous marine life which lives below the surface near the ocean shore.

Don't Worry about Your Heart by H. M. Marvin and David Loth, *Cosmopolitan*, Feb. 1953, pp. 61–63.

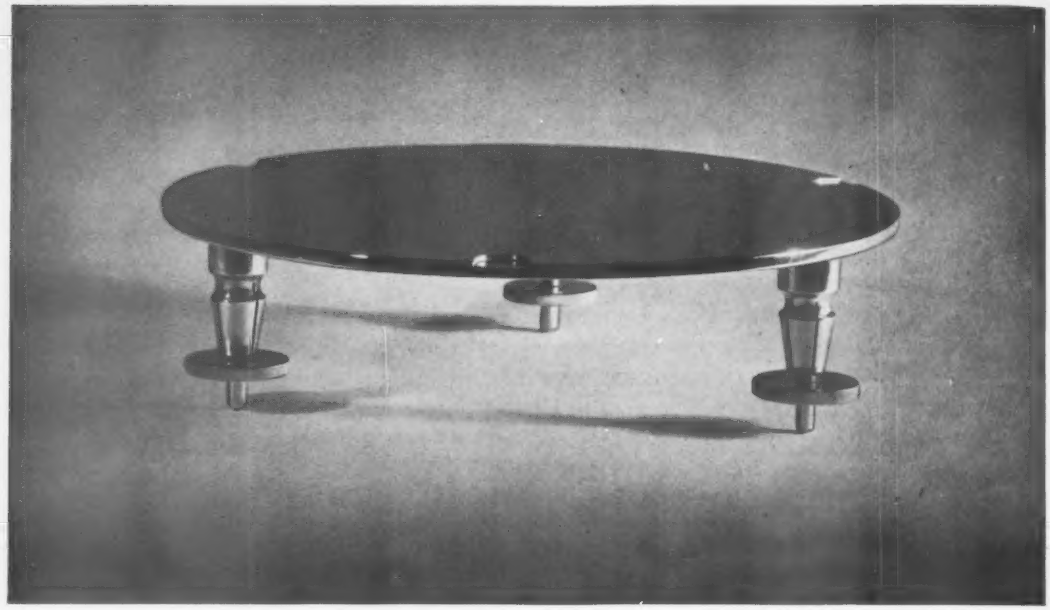
An enlightening article, not only for those who worry about straining the heart during ordinary activities, but for all of us. While it is written at the adult level it may promote a common sense attitude among teen agers.

Man of Our Century by Anthony Lewis, *Cosmopolitan*, Feb. 1953, pp. 64–71.

Lives of men devoted to the relief of human ills even in the face of the greatest obstacles merit the attention of our students. Dr. Albert Schweitzer's work with the sick of French Equatorial Africa is really inspiring.

What I've Learned from the Animals by Walt Disney, *American Mag.*, Feb. 1953, pp. 22–23 & 106–109.

An account of some interesting antics of animals told by the creator of the best Nature movies being produced for the general public.



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